Transient overvoltage (surge) protection

Transient overvoltage protection targets the destruction of electronic equipment due to transients in electrical systems. Transient overvoltage protection can prevent equipment damage and reduces the risk of fires and electric shocks.

Why is transient overvoltage protection important?

Transient overvoltages are short duration surges of voltage between two or more conductors (L-PE, L-N or N-PE), which can be caused by a variety of factors, including atmospheric origin (lightning activity), electrical switching of inductive loads, and/or power surges through resistive or inductive coupling.

Transient overvoltages can be caused by a variety of factors, including:

- **Atmospheric origin (lightning activity)**: Lightning discharges can generate transient overvoltages of millions of volts that can travel through power line conductors, electronic equipment, and distribution systems. Transient overvoltages can be extremely destructive, causing fires and electric shocks.
- **Electrical switching of inductive loads**: Transients can be generated when electrical current is switched on or off, such as with the operation of motors, transformers, and other inductive loads. These transients can cause equipment damage and increase the risk of fires.
- **Power surges through resistive or inductive coupling**: Transients can be induced in power system conductors due to field coupling, such as when power lines are disturbed. This can cause equipment damage and increase the risk of fires.

Transient overvoltages are short duration surges of voltage between two or more conductors (L-PE, L-N or N-PE), which can be caused by a variety of factors, including atmospheric origin (lightning activity), electrical switching of inductive loads, and/or power surges through resistive or inductive coupling.

Transient overvoltage protection is critical for many electrical systems, such as computers, communication systems, and medical equipment. Transient overvoltage protection is essential to ensure the safe and reliable operation of electronic equipment and to prevent equipment damage and fires.

Section 443 of BS 7671:2008 (A1:2011) defines the criteria for risk assessment and control of transients in electrical systems, including the selection and installation of suitable Surge Protective Devices (SPDs). The Section 534 and the guidance provided in Amendment 1 of BS 7671, effective from 1st January 2012, requires all electrical systems to be designed and installed to BS EN 62305-4, including the lightning protection zone (LPZ) concept, and the transient overvoltage protection zone (TOPZ) concept.
That’s why we support our transient expertise. Our sudden power surges can often be as important as a complex process, and sourcing the right overvoltage protection will be a new requirement.

For many in this sphere of work, assessing the need for transient overvoltage protection can be assessed against risk of transient overvoltages (surges). Transient overvoltage protection (SPD) brings into sharp focus the assessment principles defined within BS 7671:2008 (+A1:2011).

Amendment 1 of BS 7671 places a clear responsibility for transient overvoltage protection on system designers and installers. BS 7671:2008 and Amendment 1 require all electrical systems to be assessed against risk of transient overvoltages (surges) in line with its Sections 443 & 534.

Electrical switching of inductive loads, such as ballasts, can result in surges in voltage between two or more conductors (L-PE, L-N or N-PE), which can exceed the withstand voltage of the electrical system designs and installations to be protected. Where these are linked to separate earths by a metallic service, a voltage will be picked up by, or induced into, the line.

Resistively coupled transients are caused by differences in potential between two connected earths. This can be calculated as twice the peak system voltage (e.g. 715 V L-N) and/or the peak operating voltage of the electrical equipment. This can be a critical factor, where continuous operation of electronic equipment is essential.

Figure 1: Resistive coupling


Transient overvoltages significantly damage electronic equipment and degrade electronic systems. Outright damage to sensitive electronic equipment ( i.e. above 1.5 kV for Category I ) can occur. Equipment damage leads to unexpected failures and expensive downtime, or risk of degradation of electronic systems whenever the impulse immunity levels ( U/It curves, see Figure 3 ) aren’t achieved through installation of a suitable SPD.

Damage occurs when a transient overvoltage exceeds the withstand voltage of the electrical equipment. This can be calculated as twice the peak system voltage ( e.g. 715 V L-N ). Damage is possible above 1.5 kV for Category I. Where continuous operation of electronic equipment is essential, protection levels ( U/It curves, see Figure 3 ) must be avoided by ensuring these transient overvoltages are absorbed by the SPD. Transient overvoltages can be either of atmospheric origin ( lightning activity ) or from switching equipment failures and breakdown of insulation. Both can result in overvoltages that can exceed the withstand voltage of the electrical system designs and installations to be protected.

Protection against transient overvoltages is essential. Our transient overvoltage protection can be assessed against risk of transient overvoltages (surges). Transient overvoltage protection (SPD) brings into sharp focus the assessment principles defined within BS 7671:2008 (+A1:2011).
Transient overvoltage risk assessment

**SPD selection & installation**

- **Protection for 230/400 V TN-S or TN-C-S supplies**
  - **Normal lighting protection**
  - **Emergency lighting protection**
  - **Weatherproof protection**
  - **Combined equipotential bonding and lightning protection**

- **Fussure SPDs**
  - Designed with industry leading protection at terminal equipment by:
    - Controlled installation to BS 7671 of SPDs
    - Reduction of risk of downstream voltage surges
    - Protection of sensitive electronic equipment
    - Risk of consequential loss (to life, equipment)

- **Protection system fitted**
  - ESP 415/I/TNS
  - ESP 415 M1 Series
  - ESP 415 D1 Series
  - For LPL III & IV

- **EN/IEC 61643 standards**
  - Applies at equipment terminals
  - BS EN 61643-2 Class II test
  - BS EN 61643-11 Class III test

- **Type of SPD**
  - Type 1 SPD
  - Type 2 SPD
  - Type 3 SPD

- **Type 2+3 SPDs**
  - Type 1+2+3 SPDs

- **Protection levels**
  - Level 1
  - Level 2
  - Level 3

- **SPD connections**
  - SPD connections should be kept as short as possible ideally below 0.25 m between SPD, live conductors & earth,
  - SPD coordination

- **Effective SPD coordination within a single protective system**
  - Essential to safeguard sensitive equipment
  - There must be a minimum nominal discharge current of 40 kA 8/20 μs

- **Protection system**
  - For 230/400 V TN-S or TN-C-S supplies
  - ESP MC
  - ESP M1R
  - ESP M2R
  - ESP D1R

- **Protection system fitted**
  - ESP 415 D1 Series
  - ESP 415 M1 Series
  - ESP 415 M2 Series

- **Weatherproof protection**
  - WBX D8
  - WBX 4

- **Exposed overhead mains**
  - Protection system fitted

- **Multiple connected metallic services**
  - LED
  - Unknown

- **Protection system**
  - ESP 415 M1
  - ESP 415 D1

- **Installation of Type 1 SPDs alone**
  - However must be installed at the service entrance, to protect against transient overvoltages caused by indirect switching of inductive loads.

- **Provision of SPDs**
  - For protection measures against direct switching transients.
  - Generally not required if equipment is protected against transient overvoltages.

- **Transient overvoltages not required if equipment**
  - Equipped with transient overvoltage SPDs for (443.2.1, 443.2.2) if equipment is protected against transient overvoltages.

- **Protection is required where**
  - It must be protected against transient overvoltages.
  - The risk of consequential loss (to life, equipment)
  - Equipment is installed (443.1.1)

- **Installation against transient overvoltages**
  - Equipment should therefore be installed downstream of dangerous flashover (534.2.1).
  - The SPD's protection system fitted.
  - As close as practicable to sensitive equipment.
  - As close as practicable to the origin of the equipment (534.2.3.1.2)

- **Controlled installation**
  - BS EN/IEC 61643-2 Class II test.
  - BS EN 61643-11 Class III test.

- **Protection at terminal equipment**
  - By SPD's connecting leads
  - Protectors

- **Preferred installation (usually in the main distribution board) SDB, for electronics > 10 m from SDB**

- **For TT systems, contact Furse.**

- **Additional metallic service lines**
  - Data, against transient overvoltages is required in an assessment/installation on AC power supplies.

- **Emergency switching**
  - Of inductive loads.

- **Minor risk consequences**
  - Of consequential loss (to life, equipment)

- **Equipment installed?**
  - BS 7671 requires risk assessment in terms of potential danger (534.2.4)
  - Equipment installed? (443.2.4)

- **Distribution board to prevent**
  - Risk of consequential loss (to life, equipment)

- **Human life, e.g. safety/medical system installed?**
  - BS 7671 requires risk assessment in terms of potential danger (443.2.4)

- **Type 1 SPD**
  - Required as low as practicable in the protective system.

- **Effective coordination**
  - Combined Type SPDs (such as the Furse ESP 415/I/TNS with Type 1+2 SPD)

- **For TT systems**
  - Contact Furse.
Transient overvoltage risk assessment

BS 7671 Section 443 establishes that protection from transient overvoltages, including lightning protection (BS EN 62305) or lightning protection systems (534.2.1 NOTE 3).

Sections 443 and 534 of BS 7671 cover the protection of individuals or groups, e.g. safety/medical or combined TYPE 1+2 SPD on main distribution board to prevent overvoltages not required if equipment withstand voltage1 to Table 44.3 or impulse immunity of 1.5 kV (e.g. for servers).

The risk of consequential loss (to life, equipment or property) is assessed in 443.2.4. If terminal equipment to Category I of Table 44.3 & 44.4 of BS 7671, and local to critical equipment (534.2.1) is not significantly attenuated downstream then bonding SPDs (Type 1 or Combined Type 1+2) must be installed at service entrance, sub-distribution and at critical terminal equipment (sub-distribution level), e.g. data, signal & telecoms. The illustration demonstrates how effective SPDs are installed at key locations in the protection system fitted to meet the requirements of BS 7671.

The selection chart defines the appropriate service entrance SPD for your location. All Furse SPD sets for power and data lines are protected against transient overvoltages - lightning & AC power supplies. Following BS 7671, installation of Furse SPDs comprises a service entrance SPD on installation requirement, in line with BS 7671. The selection chart defines the appropriate service entrance SPD for your location.

Installation of Type 1 SPDs alone however is not sufficient to eliminate the risk of additive inductive voltage drops across the conductors. SPD connections should be kept as short as possible ideally below 0.25 m between SPD, live conductors & earth, but in any case not more than 0.5 m, to reduce risk of additive inductive voltage drops across the conductors. When installing termination equipment in a protected area, the SPD's connecting leads should not exceed 1 m. Where a termination equipment is remote to the SPD, the SPD's connecting leads should not exceed 10 m. The risk of consequential losses to human life, e.g. safety/medical, is assessed in 443.2.4. If terminal equipment to Category I of Table 44.3 & 44.4 of BS 7671, and local to critical equipment (sub-distribution level), is not significantly attenuated downstream then bonding SPDs (Type 1 or Combined Type 1+2) must be installed at service entrance, sub-distribution and at critical terminal equipment (sub-distribution level), e.g. data, signal & telecoms. The illustration demonstrates how effective SPDs are installed at key locations in the protection system fitted to meet the requirements of BS 7671.
Transient overvoltage risk assessment

SPD selection & installation

Protection for 230/400 V TN-S or TN-C-S supplies

Table 3. Overview of Furse Combined Type 1+2+3 SPDs

<table>
<thead>
<tr>
<th>Model</th>
<th>Voltage Protection Level</th>
<th>Short-Time Impulse (kA)</th>
<th>Non- symptom Currents (A)</th>
<th>Environmental Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESP 415 D1 Series</td>
<td>20 kA</td>
<td>250 A</td>
<td>IP20</td>
<td></td>
</tr>
<tr>
<td>ESP 415/I/TNS</td>
<td>20 kA</td>
<td>250 A</td>
<td>IP20</td>
<td></td>
</tr>
<tr>
<td>ESP 415 M1/M2/M4 Series</td>
<td>20 kA</td>
<td>250 A</td>
<td>IP20</td>
<td></td>
</tr>
</tbody>
</table>

For more information on SPD installation, contact Furse.
Defining when and where to install SPDs can be a complex process, and sourcing the right expertise can often be as important as being CPD-accredited seminars. That's why we support our transient protection on electrical system designers and installers.

Transient overvoltage (surge) protection

Transient overvoltages (surges) are short duration surges in voltage between two or more power supplies, BS 7671 does make clear the need to protect all incoming/outgoing power supplies, BS 7671:2008+A1:2011 brings into sharp focus the risk assessment, whereas Section 534 describes events, in line with its Sections 443 & 534.

Figure 2: Inductive coupling

Where continuous operation of electronic equipment is essential, degradation of electronic systems whenever the impulse immunity protection levels are exceeded, and degrade electronic systems.

Transient overvoltages significantly damage electronic equipment leads to unexpected equipment to BS 7671 Tables 44.3 & 44.4). Degradation of electronic systems begins at lower transient overvoltage levels and affects critical areas in the electrical system, in line with BS 7671 Coordinated set of SPDs at appropriate points can be achieved through installation of a protective device (SPD) or surge protection device (SPD). Transient overvoltages (surges) can cause data losses, intermittent outages and degrade electronic systems whenever the impulse immunity protection levels are exceeded, and degrade electronic systems.

Figure 3: Equipment risk

Where these are linked to separate earths by a metallic service line, the potential is shared, creating transient electromagnetic fields. If metallic services, such as overhead power lines, pass through this electromagnetic field, the energy from ground strikes flows away through the cabling and electronic circuitry. Resistively coupled transients are caused by differences in the potential between two connected earths.

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Transient overvoltage (surge) protection

Why is transient overvoltage protection required on your systems?

Transients can be classified into two main types:
- **Resistively coupled transients** are caused by differences in the potential between two connected earths.
- **Inductively coupled transients** are caused by electromagnetic pick-up.

Transient overvoltages are short duration surges in voltage between two or more conductors (L-PE, L-N or N-PE), which can result from:
- Electrical switching of inductive loads.
- Electrical or magnetic fields that can induce voltages in conductors.
- Degradation of electronic systems whenever the impulse immunity levels (e.g., 1.5 kV for Category I) exceed the withstand voltage of the electrical system, in line with BS 7671

Coordinated set of SPDs at appropriate points can be achieved through installation of a protective zone (LPZ) concept, and the protection requirements for electrical and electronic systems against transient overvoltages (surges). This is defined within BS EN 62305.

**To arrange a seminar, or for more information on protecting your installations against transient overvoltages, please contact**
e-mail: enquiry@furse.com

Seminars are conducted on customer premises or at our head office in Nottingham, UK.